STATE OF NEW MEXICO
ENVIRONMENT DEPARTMENT

IN THE MATTER OF:	**)**
THE UNITED STATES DEPARTMENT OF	**)**
ENERGY AND THE UNIVERSITY OF	**)**
CALIFORNIA.	**)**
	)
LOS ALAMOS NATIONAL LABORATORY	**)**
LOS ALAMOS COUNTY, NEW MEXICO.	**)**
	)

DETERMINATION OF AN IMMINENT AND SUBSTANTIAL ENDANGERMENT TO HEALTH AND THE ENVIRONMENT

Pursuant to the New Mexico Hazardous Waste Act ("HWA"), NMSA §§ 74-4-10.1, the Secretary of the New Mexico Environment Department (the "Department") is in receipt of evidence, and hereby determines, that the past or current handling, storage, treatment, or disposal of any solid waste or any hazardous waste may present an imminent and substantial endangerment to health or the environment. In support of this determination, the Secretary makes the following specific findings:

I. THE FACILITY

1. The Los Alamos National Laboratory (the "Facility") is a federal facility currently comprising approximately 43 square miles (27,500 acres) located on the Pajarito Plateau in Los Alamos County in north central New Mexico, approximately 60 miles north-northeast of Albuquerque and 25 miles northwest of Santa Fe. During its history, the Facility has comprised up to roughly 71 square miles (45,666 acres). The Facility is surrounded by the Pueblo of San Ildefonso, Los Alamos County, Bandelier National Monument, Santa Fe National Forest, and Bureau of Land Management lands. The Rio Grande and the tribal lands of the Pueblo of San Ildefonso border the Facility downgradient to the east. (LANL 1998e and 2001c).

2. Within the boundaries of the Facility, the Pajarito Plateau is dissected by eighteen major surface drainages, or canyons and their tributaries. The canyons run roughly east to west or southwest. From north to south, the most prominent canyons are Pueblo Canyon, Los Alamos Canyon, Sandia Canyon, Mortandad Canyon, Pajarito Canyon, Cañon de Valle and Water Canyon, Ancho Canyon, and Chaquehui Canyon. (LANL 1997a).

3. Hydrogeologic investigations have identified four discrete hydrogeologic zones beneath the Pajarito Plateau on which the Facility is located: (1) canyon alluvial systems; (2) intermediate perched water in the volcanic rocks (Tschicoma Formation and upper and lower members of the Tshirege Member of the Bandelier Tuff); (3) canyon-specific intermediate perched water within the Otowi Member of the Bandelier Tuff, Cerros del Rio basalt and sedimentary units of the Puye Formation; and (4) the regional aquifer. (LANL 1998e).

4. Habitat for several federally threatened and endangered species, including the bald eagle, the southwestern flycatcher, and the Mexican spotted owl have been identified on Facility property. Other species of concern, such as Jemez Mountains salamander, spotted bat, whooping crane and black-footed ferret, may occur on facility lands. The Mexican spotted owl, southwestern flycatcher, bald eagle and Jemez Mountains salamander have been recorded on Facility and Los Alamos County lands. (LANL 1998e).

II. FACILITY OPERATIONS

5. The Facility began operations in 1943 when the United States Army Manhattan Engineer District was established for the research and development of an atomic bomb. Current and historic operations have included nuclear weapons design and testing; high explosives research, development, fabrication, and testing; chemical and material science research; electrical research and development; laser design and development; and photographic processing. (LANL 1998e).

6. The Facility is currently owned and operated by the United Sates Department of Energy and operated by the University of California (the "Facility Operators").

7. The Facility has been divided into numerous Technical Areas, or "TA's." Currently, 49 TA's exist; however, many former TA's have ceased operations and have been abandoned, have been combined with other TA's, or were cancelled before becoming operational. (CDCP 2002).

8. *TA-2*. TA-2 is located in Los Alamos Canyon near the western boundary of the Facility. It currently houses the Omega West Reactor but has historically housed water boiler reactors and "Clementine," a mercury cooled plutonium fast reactor. The Omega West Reactor is scheduled for decontamination and decommissioning in 2006. Cooling tower outfalls discharged to Los Alamos Canyon. (DOE 1987; LANL 2001c; CDCP 2002).

9. *TA-3*. TA-3 is located at the western boundary of the Facility. It includes the Administration Complex and support facilities as well as chemical and materials science laboratories. The Chemical and Metallurgical Research building, a Van de Graaff Accelerator (Ion Beam Facility), technical shops, and cooling towers from a power plant are among the current and historic operations housed in this part of the Facility. (DOE 1987; LANL 2001c).

10. *TA-10.* Former TA-10 is located north of the Facility in Bayo Canyon, adjacent to TA-74. The Facility Operators conducted hydrodynamic tests using conventional explosives and radiochemical research at TA-10 from 1943 to 1961. In 1963, the TA structures were decontaminated and demolished. The land was then transferred to the County of Los Alamos, and is no longer part of the Facility. (LANL 1992a).

11. *TA-16.* TA-16 is located on the southwestern side of the Facility. TA-16 includes high explosive, plastic and adhesive research, development, testing, and production facilities. The operations include pressing, casting and milling of high explosives, plastic operations, photographic laboratories, cooling towers, surface disposal areas, and historic wastewater outfalls in addition to open burn and open detonation activities. (LANL 1993, 1998b, 1998c, and 2001c).

12. *TA-21.* TA-21 is located on DP Mesa on the northern side of the Facility. TA-21 was the plutonium processing area where the Facility Operators produced metal and alloys of plutonium and other transuranic elements from nitrate solution feedstock, processed polonium, and actinium, and produced initiators (a weapons component) from 1945 until 1978. TA-21 also housed treatment facilities for industrial wastewater from the plutonium processing facility. Chlorinated and non-chlorinated solvents, metals such as beryllium, cadmium, chromium, lead, mercury, and nickel, as well as other constituents were used at TA-21. (LANL 1991 and 2001c).

13. *TA-45.* Former TA-45 housed an industrial wastewater treatment plant located within the Los Alamos townsite that discharged to a small tributary of Acid Canyon. The industrial treatment plant operated from 1951 to 1964. The treatment plant served TA-3, TA-21, TA-43, and TA-48, as well as former TA-1. Prior to 1951, untreated industrial wastewater was discharged slightly upgradient from former TA-45. Discharge to the untreated industrial wastewater outfall originated from the former main technical area, TA-1. (LANL 1981).

14. *TA-49.* TA-49, the Frijoles Mesa Site, is approximately 1280 acres located on the southwestern boundary of the Facility. Since the mid-1940's, TA-49 has been used as a buffer zone for activities at adjacent firing sites. Between 1959 and 1961, underground hydronuclear and related experiments were conducted at TA-49. (LANL 1987 and 1998a).

15. *TA-50.* TA-50 is located in the center of the Facility, bounded by Mortandad Canyon to the north, Two Mile Canyon to the south, TA-55 to the west, and TA-63 to the east. TA-50 includes a waste reduction characterization facility, an industrial wastewater treatment plant, several container storage areas, and a 12-acre landfill comprised of pits and shafts. The industrial wastewater treatment plant has been in operation since 1963. The landfill was operated from 1948 until 1964. (LANL 1992b, 1997c, and 2001c).

16. *TA-54.* TA-54 is located at the eastern end of Mesita del Buey on the eastern side of the Facility. The Facility Operators have used TA-54 since the 1950's as the primary waste disposal area for the Facility. TA-54 includes a waste characterization area, container storage areas, a waste transfer facility, and numerous surface impoundments, pits, trenches, and shafts used for waste disposal. (LANL 1992d, 2000a, and 2001c).

17. Inventories of selected organic solvents indicate that during a 16 year period from the early 1970's to middle 1980's the Facility used the following quantities of solvents each year: 40,260 to 86,460 pounds of trichloroethane; 858 to 44,480 pounds of trichloroethylene; 14,817 to 41,360 pounds of acetone; 18,400 to 70,840 pounds of freons; 4.4 to 20,020 pounds of perchloroethylene; 1350 to 17,820 pounds of kerosene; 880 to 48,400 pounds of methyl ethyl ketone; 132 to 7260 pounds of toluene; 374 to 4840 pounds of methylene chloride; 352 to 1100 pounds of chloroform; 132 to 660 pounds of carbon tetrachloride; 26 to 398 pounds of benzene. Lesser amounts of hexane, xylene, tetrahydrofuran and dioxane were also utilized during this period although data is only available for a few years during this time frame. (CDCP 2002).

18. The Facility Operators have conducted dynamic testing at firing sites, which used a variety of high explosive compounds ("HE"), barium, beryllium, lead, mercury, and other metals. (DOE 1979).

III. WASTE MANAGEMENT

A. General

19. As a result of the Facility operations, from approximately 1943 to the present, the Facility Operators have generated, treated, stored, disposed of, and otherwise handled solid wastes, hazardous wastes, hazardous waste constituents, and hazardous wastes mixed with radioactive wastes at the Facility. (E.g., DOE 1987 and 2001; LANL 1998b, 1998c, 1998e, and 2000a).

20. The Facility Operators have disposed hazardous and solid wastes in septic systems, pits, surface impoundments, trenches, shafts, landfills, and waste piles throughout the Facility. The Facility Operators have also discharged industrial wastewater and other discharges from outfalls into many of the canyon systems at the Facility. (E.g., Rogers 1977; DOE 1987 and 2001; LANL 1991, 1992b, 1992c, 1993, 1994, 1995, and 1998e; CDCP 2002)

21. Hazardous wastes and hazardous constituents, other solid wastes, and radionuclides have been released into Los Alamos Canyon, Pueblo Canyon, Pajarito Canyon, Cañon de Valle, Water Canyon, and Sandia Canyon, as well as other canyons. (Purtymun 1975; DOE 1987; LANL 1981, 1997, 2000a, and 2001a; CDCP 2002).

22. As a result of the releases, the Facility has identified over 2100 solid waste management units ("SWMU's") and "areas of concern" ("AOC's") where hazardous and solid wastes have been disposed. (LANL 1998d).

23. The Facility Operators have disposed of hazardous wastes, hazardous constituents, and other solid wastes at the Facility. These wastes include chlorinated and nonchlorinated solvents such as carbon tetrachloride, methylene chloride, trichloroethane, trichloroethylene, tetrachlorethylene, benzene, toluene, acetone, chloroform, and methyl ethyl ketone ("MEK"); high explosive compounds ("HE") such as trinitrotoluene ("TNT"), dinitrotoluene compounds, octahydro-1357-tetranitro-1357-tetrazocine ("HMX"), and cyclonite ("RDX"); corrosive and toxic gases; metals such as arsenic, barium, beryllium, cadmium, chromium (including chromium VI), copper, lead, mercury, molybdenum, silver, and zinc; cyanide; polychlorinated biphenyls ("PCB's"); pesticides such as 2,4-D; perchlorate; other inorganic contaminants such as nitrates, ammonia, and fluoride; various radionuclides such as tritium; and other wastes. (E.g., DOE 1979, 1987 and 2001; LANL 1981, 1998c, 1998e, 2000a, and 2001a; CDCP 2002).

24. The Facility Operators have disposed of radioactive wastes, some of which are also solid wastes, at the Facility. In some cases, the radioactive wastes were mixed with hazardous wastes and in other cases they were disposed of separately. These radioactive wastes include isotopes of plutonium and uranium as well as a variety of activation and mixed fission products including tritium, actinium-227, cobalt-60, strontium-90, cesium-137, technetium-99, americium-241. (DOE 1979, 1987 and 2001; LANL 1998c, 1998e, and 2000a; CDCP 2002).

25. Throughout the Facility, large quantities of solvents have been released at accelerator operations. Operational accelerators currently exist at TA-15 (PHERMEX) and TA-53 (LAMPF). Historically, several accelerators were utilized by the LANL facility. TA-1 and TA-

3 housed Van de Graaff accelerators, a cylcotron, a betatron, the Cockroft-Walton and the Short Tank accelerators. (CDCP 2002).

26. Some of the various waste disposal units at the Facility have been categorized into "Material Disposal Areas" or "MDA's" within many of the Technical Areas. (CDCP 2002). In addition, TA-49 also includes several designated "Areas" at which contaminants have been disposed as a result of various tests and experiments.

B. TA-21 Material Disposal Areas

1) MDA A

27. The Facility Operators disposed of solid and radioactive wastes in MDA A from 1945 to 1949 and again from 1969 to 1977. Waste streams included laboratory equipment, building construction debris, chemicals, and other solid wastes. In addition, corroded and leaking 55-gallon drums of iodide waste were stored on the eastern portion of MDA A in the 1950's, resulting in releases of contaminants to the ground surface. (Rogers 1977; DOE 1987; LANL 1991).

28. On the western portion of MDA A, a liquid solution containing plutonium-239/240 was disposed in two subsurface 50,000-gallon steel tanks. Liquid was later removed from the tanks, but an unknown volume of radioactive sludge and liquid remain in the tank bottoms. (Rogers 1977; DOE 1987; LANL 1991).

29. In 1969 a large pit was constructed in the center of MDA A. Contaminants placed into this pit include plutonium-239/240, plutonium-238, uranium-235, depleted uranium, other unspecified radionuclides, and asphalt. (Rogers 1977; DOE 1987; LANL 1991).

2) MDA B

30. The Facility Operators disposed of solid wastes in MDA B from 1945 until 1948. MDA B covers six acres and is comprised of at least five disposal pits. Wastes disposed in MDA B include organic chemicals, perchlorate, ethers, solvents, corrosive gases, and radionuclides. In addition, at least one truck contaminated with fission products from the Trinity test and other large pieces of debris were disposed in MDA B. (Rogers 1977; DOE 1987 and 2001; LANL 1991 and 1998b).

31. Wastes were placed in four or five pits at MDA B, one of which has estimated dimensions of 15 feet wide, 300 feet long, and about 12 feet deep. (Rogers 1977; DOE 1987 and 2001; LANL 1991 and 1998b).

3) MDA T

32. The Facility Operators disposed of solid, hazardous, and radioactive wastes containing hazardous constituents in MDA T from 1945 to 1983. MDA T covers approximately 2.21 acres containing four absorption beds used to dispose of industrial wastewater, a retrievable waste storage area, a series of disposal shafts, an acid holding tank and acid sump, a caisson built in

1959, and two surface spill areas of americium-241 paste. (Rogers 1977; DOE 1987; LANL 1991 and 1997b).

33. The four absorption beds at MDA T measure 120 feet long, 20 feet wide, and 4 feet deep. Over 18 million gallons of industrial wastewater was discharged to the four absorption beds between 1945 and 1983. (Rogers 1977; DOE 1987; LANL 1991 and 1997b).

34. A satellite container storage area for alcohol, acetone, and freon is located at MDA T. The storage area has been inactive since 1990. (Rogers 1977; DOE 1987; LANL 1991 and 1997b).

35. Roughly 60 disposal shafts were constructed between the four absorption beds at MDA T. The shafts measured 8 feet in diameter and ranged from 18 to 68 feet deep. Some of the shafts were sealed in asphalt. Between 1968 and 1983, the disposal shafts were used to dispose of "cement pastes" of neutralized americium, "strip" reportedly containing ammonia as well as hazardous constituents such as chromium and nickel, and treatment sludge from processes throughout TA-21. Other wastes disposed in MDA T shafts include mixed wastes, treatment sludge, industrial wastewater, and bathyspheres filled with plutonium-239/240. The liquid effluent was mixed with cement prior to disposal, resulting in an estimated volume of 902,265 gallons, or 3418 cubic meters, of waste disposed in the shafts. (Rogers 1977; DOE 1987; LANL 1991 and 1997b).

4) MDA U

36. The Facility Operators disposed of wastewater and cooling tower effluent in MDA U from 1948 until sometime after 1976. MDA U is approximately 0.2 acres and consists of two absorption beds used for subsurface disposal of industrial wastewater and an associated sump located between the two beds. The primary contaminants disposed of at MDA U include polonium-210, actinium-227, tritium, uranium, and plutonium. (DOE 1987; LANL 1991).

5) MDA V

37. The Facility Operators discharged at least 40 million gallons of effluent into MDA V between 1945 and 1961. MDA V is approximately 0.88 acres and consists of three absorption beds and associated sumps used for the subsurface disposal of wastewater generated by a Facility laundry operation. Wastewater discharged to the pits contained barium and various radionuclides. In addition, soil samples collected in 1982 contained elevated levels of tritium. (DOE 1987; LANL 1991).

C. TA-49 Material Disposal Areas

1) MDA AB

38. The Facility Operators detonated HE and conducted 44 nuclear device safety and related tests in underground shafts at MDA AB, also known as Areas 2, 2A and 2B of TA-49. These operations used conventional explosives and small amounts of fissile material. The tests resulted in releases of HE, barium, uranium, plutonium-239, americium-241, tritium, lead, and beryllium in addition to other radioactive tracers used in the tests. The majority of the releases

are in shafts at depths ranging from 50 to 120 feet below the ground surface. Estimates of some of the contaminants in the subsurface include 90,000 kg of lead, 11 to 13 kg of beryllium, 93 kg of enriched uranium, 82 to 169 kg of depleted uranium, and 40 kg of plutonium. (LANL 1987, 1992c, and 1998a).

2) Areas 1, 3, and 4

39. The Facility Operators conducted various containment studies and downhole studies, and developed confinement and sample recovery techniques in underground shafts at Areas 1, 3, and 4 of TA-49. Chemicals used in these studies include uranium tracers, uranium-235 and 238, plutonium-239, and neptunium-239 tracers. (LANL 1987 and 1992c).

3) Area 11

40. The Facility Operators conducted radiochemical research and small-scale shot experiments using HE from 1959 to 1961 at Area 11 of TA-49. Area 11 consists of the former radiochemistry laboratory, associated leach field, and a small-scale shot area. The radiochemistry laboratory was demolished in 1971. (LANL 1992c).

4) Area 12

41. The Facility Operators used Area 12 of TA-49 for confinement experiments in 1960 and 1961, and later to support operations at the Cable Test Pull Facility. The confinement experiments consisted of HE detonations in sealed metal "bottles" that were placed in a 30-foot shaft located within the Bottle House structure. (LANL 1992c).

D. TA-50 Material Disposal Area

42. Only one Material Disposal Area, MDA C, is located within TA-50. The Facility Operators disposed of a large volume of hazardous, radioactive, and mixed waste in MDA C from 1948 until 1974. MDA C encompasses 11.8 acres and consists of seven disposal pits, a chemical disposal pit, and 108 shafts. High activities of radionuclides, including tritium, and high concentrations of volatile organic compounds have been released from MDA C to the vadose zone. (Rogers 1977; LANL 1992b; DOE 2001).

E. TA-54 Material Disposal Areas

1) MDA G

43. The Facility Operators have used MDA G for the disposal of a variety of Facility wastes from 1957 to the present, and continue to use it for waste storage and disposal. Since 1957, MDA G has been the Facility's primary radioactive and mixed waste disposal site. From 1957 until at least 1990, the Facility Operators disposed of solid, hazardous, mixed, and radioactive wastes at MDA G. Since 1990, the Facility Operators have reported to use MDA G only for the disposal of radioactive wastes. Some of the radioactive wastes disposed at MDA G since 1990 are also solid wastes. MDA G consists of hazardous and radioactive waste container storage areas, 47

disposal pits, four disposal trenches, and 218 disposal shafts. (Rogers 1977; DOE 1987; LANL 1992d and 2000a).

44. MDA G encompasses 100 acres. Hazardous, solid, mixed and radioactive wastes have been placed in unlined pits, trenches and shafts since 1957. Classified mixed waste was reportedly disposed at MDA G until 1985. There are more than 34 pits, 4 rectangular trenches, and 218 vertical shafts at MDA G. (Rogers 1977; DOE 1987; LANL 1992d and 2000a).

45. The pits at MDA G vary in size, but are typically 200 to 600 feet long, 60 to 100 feet wide, and 65 feet deep. When filled, roughly 4 feet of crushed volcanic tuff and 4 inches of topsoil are used to cover each pit. On average, 35% of each pit is estimated to be waste material and the rest is crushed volcanic tuff. (Rogers 1977; LANL 1992d and 2000a).

46. The four trenches at MDA G are 200 to 300 feet long, 13 feet wide, and 8 feet deep. Waste disposed of in these trenches is retrievable transuranic (TRU) waste and was reportedly packaged in 30-gallon drums inside concrete casks. (Rogers 1977; LANL 1992d and 2000a).

47. The shafts or "disposal wells" are typically 3 to 6 feet in diameter and 65 feet deep. Wastes disposed in the shafts required special packaging, special handling or segregation. Tritium, highly activated metals, PCB-contaminated waste, and hydrocarbon oil are among the wastes disposed in the shafts. (Rogers, 1977; LANL 1992d and 2000a).

2) MDA H

48. The Facility Operators disposed of hazardous and radioactive wastes, including HE, in nine shafts at MDA H from 1960 to 1989. (LANL 1992d and 2000a).

3) MDA L

49. The Facility Operators disposed of liquid hazardous and radioactive wastes at MDA L from 1959 to 1986. MDA L covers roughly 2.6 acres and consists of hazardous and radioactive waste container storage areas, one inactive subsurface disposal pit, three inactive surface impoundments, and 34 inactive disposal shafts. The area is covered by an asphalt pad and is presently used for permitted waste storage and treatment. (LANL 1992d and 2000a).

50. The dimensions of the surface impoundments at MDA L vary but range from 35 to 75 feet long, 12 to 18 feet wide, and 10 feet deep. The impoundments were used at various times from 1972 to 1986. The primary function of two of the impoundments was to evaporate treated salt solutions and liquid electroplating wastes. One of these impoundments was filled to 25% of its 2000 cubic foot capacity. The third impoundment was used to neutralize lithium hydride, a reactive waste. This impoundment was also used as secondary containment for oil storage for an unknown duration. (LANL 1992d and 2000a).

51. The dimensions of the 34 shafts or "disposal wells" at MDA L range from 3 to 8 feet in diameter and 15 to 65 feet deep. Most of the shafts are 60 feet in depth. Disposal in the shafts began in 1975 and lasted until 1985. (LANL 1992d and 2000a).

52. The disposal pit operated from 1964 to 1978. It is approximately 200 feet long, 15 feet wide, and 12 feet deep. The pit was used for the disposal and treatment of uncontained liquid waste and drums and is filled to an estimated 10% of its 28,800-cubic foot capacity. Ammonium bifluoride, acid and caustic solutions, cyanide solutions, and chromium wastes were treated and disposed of at the pit. In 1992, the Facility acknowledged that the batch treatment of liquid waste "may have facilitated the downward migration of liquid contaminants along fractures within the tuff." (LANL 1992d).

III. RELEASES OF CONTAMINANTS

A. General

53. These waste disposal and other waste management activities at the Facility have resulted in the release of solid and hazardous wastes, hazardous waste constituents, mixed wastes, and radioactive wastes to the environment. (E.g., Purtymun 1975; DOE 1987 and 2001; LANL 1981, 2001a, and 2001c; CDCP 2002).

54. Contaminants that have been released into, and detected in, soils and sediments at the Facility include HE compounds; metals such as arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, molybdenum, silver, and zinc; PCB's; various radionuclides such as tritium; and other contaminants. (E.g., DOE 2001; LANL 1998b, 1998c, 2000a, 2001a, and 2001c; CDCP 2002).

55. Contaminants that have been released into, and detected in, groundwater beneath the Facility include HE compounds; volatile organic compounds such as trichloroethylene, dichloroethylene, and dichcloroethane; metals such as molybdenum, manganese, beryllium, lead, cadmium, and mercury; perchlorate; other inorganic contaminants such as ammonia, nitrate, and fluoride; radionuclides such as tritium; and other contaminants. Contaminants have been detected beneath the Facility in all four groundwater zones. (E.g., Purtymun 1975; LANL 1981, 2001a, 2001c, and 2002; CDCP 2002).

56. HE compounds and metals have been detected in groundwater beneath the Facility at levels in excess of maximum contaminant levels ("MCLs") set by the EPA under the federal Safe Drinking Water Act, 42 U.S.C. §§ 300f to 300j-26. (EPA 2000; LANL 1981, 1998b, 1998c, and 2002; NMED 1996).

57. Nitrate and molybdenum have been detected in groundwater beneath the Facility at levels in excess of numerical standards set by the New Mexico Water Quality Control Commission ("WQCC"), at 20.6.2.3103 NMAC. (LANL 1981 and 2001c; NMED 1996).

58. Perchlorate has been detected in groundwater beneath the Facility at levels in excess of EPA's proposed drinking water equivalent level of 1 μ/L. (LANL 2001c and 2002).

59. Perchlorate, which is a byproduct of the processing of plutonium and is also used in high explosives (LANL 1999) and rocket fuel, is very soluble, mobile, and persistent in the environment. Therefore, perchlorate often precedes other less mobile contaminants.

B. Releases of Contaminants from TA-2

60. At various times, the Facility Operators operated nuclear reactors in TA-2. Various contaminants were released from reactor cooling towers at TA-2, including chromium (including chromium VI), mercury, solvents, and radionuclides. Chromium, other metals, and perchlorate have been detected in the alluvial groundwater system downgradient of the TA-2 reactor complex. (DOE 1987; CDCP 2002).

61. Loss of chromium VI from the TA-2 Omega West Reactor cooling tower was reportedly 0.05 pounds per hour in the form of potassium dichromate. (DOE 1987; CDCP 2002).

62. The chromium VI concentration in the discharge was reportedly 25 mg/L from the TA-2 Omega West Reactor. (CDCP 2002).

63. The cooling tower at the Water Boiler Reactor at TA-2 reportedly "rained" chromium from the sky. (CDCP 2002).

64. Mercury coolant was spilled from the Clementine Reactor at TA-2 in December 1948. (CDCP 2002).

C. Releases of Contaminants from TA-3

65. From the 1950's to the 1970's, the Facility Operators operated a power plant at TA-3. The TA-3 power plant discharged between 128,000 and 288,000 gallons per day of wastewater into Upper Sandia Canyon. The power plant used roughly 36 pounds per day of chromate phosphate-zinc corrosion inhibitors. Chromium levels in the discharged wastewater averaged up to 34 ppm, and chromium VI was estimated to be half that average. Chromate in discharged wastewater collected four miles down stream averaged 10 to 15 ppm. Chromium VI has been detected in surface water two miles down stream of the outfall. (DOE 1987).

66. Cadmium, beryllium, lead, and mercury were detected in surface water samples taken at two locations up to two miles downgradient of the sewage treatment plant and power plant outfalls.

D. Releases of Contaminants from TA-16

67. Since operations began in 1951, the Facility Operators have used Building 16-260 in TA-16 to machine high explosives. Contaminants released from Building 16-340 include high explosive compounds (e.g., HMX, RDX, and TNT), solvents, and natural uranium. (LASL 1971 and 1976; LANL 1993, 1998b and 1998c).

68. During the six month period from November 1970 to April 1971, the chemical inventory for Building 16-340 included 11 pounds of toluene; 750 pounds of methyl ethyl ketone; 72 pounds of methylene chloride; 110 pounds of methanol; 11 pounds of ethyl acetate; 55 pounds of 1,2-dichloroethane; 3 pounds of chloroform; 330 pounds of n-butyl acetate; 500 pounds of ammonium sulfate; and 700 pounds of acetone. (LANL 1993).

69. From 1951 until 1988, machine turnings and high explosive wastewater from Building 16-340 was discharged untreated to the 16-260 outfall, a small tributary to Cañon de Valle. In the early

1980's, a 250 foot weir-type green plastic air-stripper (the Fish Ladder) was fitted to the outfall to allow some aeration of solvents before final discharge to the drainage. In 1989, a distiller was installed in Building 16-340 to help trap solvents before discharge to the Fish Ladder. In November 1996, the wastewater was routed to 13 sumps located outside the building. (LANL 1993, 1998b, and 1998c).

70. Data from 1994 indicate that 2.5 million gallons of wastewater was discharged from the 16-260 outfall that year. (LANL 1993).

71. Investigations conducted during the 1990's detected RDX, TNT, HMX, dinitrotoluene (DNT), amino-DNT compounds, trinitrobenzene (TNB), dinitrobenzene, pentaerythritol tetranitrate (PETN), barium nitrate, tetryl, nitroguadine, triaminotrinitrobenzene (TATB), ammonium nitrate, various plastic binders, acetone, acetonitrile, chloromethane, dichloroethane, dichlorobenzene, isopropyltoluene, tetrachloroethene, trichloroethene, anthracene, bis(2-ethylhexyl)phthalate, diethylphthalate, butylbenzylphthalate, barium, beryllium, copper, cadmium, chromium, cobalt, lead, nickel, silver, vanadium, uranium, and zinc in addition to other constituents. (LASL 1971 and 1976; DOE 1987; LANL 1993, 1998b, and 1998c).

72. The TA-16 Building 16-260 outfall, pond and drainage channel was excavated in 2000, and the contaminated material was removed and disposed of. Prior to the excavation, soil in the area was contaminated with HE compounds at levels up to 20% by weight, and barium at up to 33,000 ppm. Today, RDX levels in surface water below the outfall are greater than 800 ppb and barium levels in sediments are approximately 40,000 ppm. During the drilling of R-25, HE compounds, such as RDX, were detected in the intermediate zone at levels above EPA health advisories. (LANL 1998b and 1998c; NMED 2000; EPA 2000 and 2002).

73. The EPA drinking water health advisory for RDX is 2 ppb, the NMED residential soil screening level for RDX is 44 ppm and the EPA residential screening level for barium is 5400 ppm in soil.

74. The Building 16-260 outfall is a primary source of water contamination observed in SWSC Spring, Burning Ground Spring, Martin Spring, surface and alluvial waters of Cañon de Valle, and in perched groundwater (approximately 740 feet below ground surface) observed during drilling of regional aquifer well R-25. (LANL 1998a and 1998d).

E. Releases of Contaminants from TA-21

75. From 1945 until 1978, the Facility Operators produced metal and alloys of plutonium and other transuranic elements at TA-21. TA-21 also housed treatment facilities for industrial wastewater from the plutonium processing facility. Chlorinated and non-chlorinated solvents and metals such as beryllium, cadmium, chromium, lead, mercury, and nickel were used at TA-21. (LANL 1991 and 2001c).

76. From 1945 to 1952, industrial wastewater effluents from TA-21 were disposed into the absorption beds at MDA T. In 1952, a wastewater treatment facility at Building 21-35 began operation and discharged to the SWMU 21-011(k) outfall. Sludge and remaining wastes from the treatment process were reportedly disposed of in shafts at MDA T and other MDA's, presumably MDA's C and G. Treated wastewater from the plant was discharged to DP Canyon.

The treatment facility at building 21-35 was replaced in 1967 by a larger capacity treatment facility, Building 21-257. (LANL 1981 and 1991).

77. From 1945 through 1952 an estimated 12.6 to 14 million gallons of untreated wastewater from Building TA-21-35 was discharged to the absorption beds. (DOE 1987; LANL 1991).

78. After the Building 21-35 industrial treatment facility became operational in 1952, an additional estimated 4.3 to 5.7 million gallons of wastewater was discharged to the absorption beds at MDA T. (Rogers 1977; LANL 1991).

79. From 1952 to 1975, an estimated 65 million gallons of treated industrial wastewater was discharged to outfall 21-011(k). In addition, an unknown volume of untreated industrial wastewater was discharged directly to the 21-011(k) outfall. (LANL 1981 and 1991).

80. In 1973, flow rates from the 21-011(k) Outfall were 143,000 gallons per month. (DOE 1987).

81. In 1973, the treated wastewater from the Building TA-21-257 treatment facility contained cadmium at levels from 1 to 500 µg/L; chromium VI at levels from <4 to 7 µg/L; total chromium at levels from <4 to 380 µg/L; copper at levels from <2 to 1500 µg/L; mercury at levels from <0.02 to 25 µg/L; lead at levels from <0.1 to 1300 µg/L; zinc at levels from <2 to 1120 µg/L; nitrate at levels from 31 to 1087 mg/L; and fluoride at levels from 3 to 149 mg/L. (LASL 1973).

82. In 1976, the treated wastewater from the Building 21-257 treatment facility contained cadmium, chromium (including chromium VI), copper, lead, mercury, zinc, nitrates, fluoride, and ammonia. (DOE 1979).

83. In 1971 and 1972, surface water in DP Canyon contained average cadmium at concentrations of 6.9 µ/L in solution and 0.43 µ/L in particulates; beryllium concentrations of 0.3 µ/L in solution and <0.25 µ/L in particulates; lead concentrations of 1.8 µ/L in solution and 2.8 µ/L in particulates; and mercury concentrations of 0.09 µ/L in solution and <0.02 µ/L in particulates. (DOE 1987; LANL 1981).

84. Cadmium, copper, lead, nickel, silver, and zinc exceed background concentrations in shallow (<18 inches) samples while TCE, silver, chromium, cyanide and some radionuclides have been detected to depths of 100 feet, the furthest extent of investigation thus far. (LANL 1991 and 1995).

F. Releases of Contaminants from Former TA-45

85. Industrial wastewater generated as a result of nuclear materials research at the original main Technical Area (TA-1) during the early years of the Facility was discharged to a small tributary of Acid Canyon, untreated, between 1943 and 1951. Roughly 30 million gallons of untreated industrial waste was discharged between 1943 and 1951. (LANL 1981).

86. The Facility Operators built an industrial wastewater treatment plant located at former TA-45, which went into operation in 1951. The plant operated until 1964, shortly after a new facility at TA-50 was built. (LANL 1981 and 1995).

87. The volume of treated wastewater effluent from the treatment plant at former TA-45 was 5.8 million gallons in 1951, and increased to 17 million gallons in 1962. (LANL 1981).

88. In 1964, the volume of treated effluent from the wastewater treatment plant at TA-50 was 235,000 gallons. (LANL 1981).

89. The estimated total volume of wastewater discharged from former TA-45 and the outfall is approximately 166 million gallons, 30 million of which was not treated. (LANL 1981).

90. During a recent investigation of the sediments found in the South Fork of Acid Canyon, the hazardous constituents detected included mercury, lead, silver, cadmium, chromium, as well as polychlorinated biphenyls (PCB's). Additionally, isotopic plutonium, strontium-90, cesium-137, and americium-241 were detected, indicating that hazardous constituents were discharged concurrently with radionuclides. (LANL 1981, 2000b and 2001a).

G. Releases of Contaminants from TA-50

91. In 1963, the Facility Operators moved the wastewater treatment operation from former TA-45 to TA-50, although discharges continued at TA-45 for one additional year. TA-50 houses the Radioactive Wastewater Treatment Facility that collects and treats wastewater effluent from throughout the Facility. (DOE 1987; LANL 1981).

92. Facility operations that generated wastewater sent to TA-50 included handling of heavy metals and beryllium, analytical chemistry laboratories, target preparation facilities, research facilities. Solvents and other organics (e.g., scintillation cocktails that contain benzene, toluene, and xylene) as well as heavy metals enter the treatment plant and remain in residual treatment sludge and effluent. (DOE 1987).

93. From 1963 to 1995, the volume of treated effluent from the wastewater treatment plant at TA-50 was roughly 341 million gallons. (DOE 1979 and 1987; LANL 1992b and 1997).

94. Sampling data collected over the past ten years at and downstream of the outfall show elevated levels of trace metals and organic compounds. Historic data from treated liquid effluent released to Mortandad Canyon, provided by the LANL facility, indicate that beginning in 1973 with no reporting in 1974 through 1977, the inorganic constituents cadmium, chromium (including chromium VI), copper, mercury, lead, zinc, cyanide, nitrate, ammonia, and fluoride were detected in the treated effluent. Annual average concentrations were often above current drinking water standards for individual contaminants. (DOE 1979 and 1987; LANL 1992b and 1997).

95. From 1963 to 1989, cadmium, chromium, cyanide, mercury, lead, and zinc were monitored in the effluent from the wastewater treatment plant at TA-50. Reported average concentrations of

these contaminants indicate that the concentrations were often above drinking water standards. (Purtymun 1975; LANL 1992b and 1997c).

96. In 1973, the treated wastewater from the wastewater treatment plant at TA-50 contained cadmium at levels from <1 to 560 µg/L; chromium VI at levels from <4 to 65 µg/L; total chromium at levels from <4 to 220 µg/L; copper at levels from <2 to 5280 µg/L; mercury at levels from 1 to 149 µg/L; lead at levels from <0.1 to 2600 µg/L; zinc at levels from <2 to 260 µg/L; and nitrate at levels from 27 to 2093 mg/L. (LASL 1973).

97. Between 1963 and 1972, the annual average concentration of nitrate as nitrate in treated wastewater from the wastewater treatment plant at TA-50 was 217 mg/L, with a maximum of 766 mg/L in 1972. (Purtymun 1975).

98. In 2001, monthly composite samples from the wastewater treatment plant atTA-50 contained perchlorate at levels from 3 to 950 µg/L. (LANL 2002).

99. Analytical results from 1971, 1972, and 1997 indicate cadmium, beryllium, lead, and mercury were detected in alluvial wells down gradient (2844 m) of the TA-50 outfall. (Purtymun 1975, LANL 1997c and 2001c).

100. Plutonium, a strongly sorbing element, was detected in shallow alluvial aquifer well MCO-7.5 (2844 m down gradient of the outfall) within a couple of years after operations at TA-50 began, and plutonium continues to be detected. (Purtymun 1975; LANL 1997c and 2001c).

101. Available documentation indicates that perchlorate analyses were first performed on alluvial ground water in 1999 and, since then, levels have been detected as high as 440 µg/L. (LANL 2002). Perchlorate has also been detected at 4.19 µg/L, above the Environmental Protection Agency provisional drinking water equivalent level of 1 µg/L, in regional aquifer well R-15 downgradient of the outfall. (LANL, 2002). Perchlorate, nitrate, and tritium have been detected at levels from 12 to 145 µg/L in intermediate groundwater zones beneath Mortandad Canyon at MCOBT-4.4 and R-15. (LANL 2002).

102. Cadmium, lead, mercury, nitrates, fluoride, tritium, strontium-90, and plutonium (a strongly sorbing constituent), among others contaminants, were detected in surface water, alluvial groundwater, perched groundwater and springs in Pueblo and lower Los Alamos Canyons between 1946 and 2000. (Purtymun 1975; LANL 1981 and 2001a).

103. The waste disposed at MDA C at TA-50 includes arsenic, antimony, barium, beryllium, cerium, cesium, copper, cyanides, lead, mercury, silver, thallium, tantalum, zinc, pyrophoric metals, compressed gas cylinders, and acid solutions. In addition, acetone, benzene, high explosives (e.g., TNT), trichloroethylene and other solvents, waste oil, and radioactive organic solutions have been disposed of at this site. Plutonium contaminated sodium loops from a reactor were also disposed at MDA C. Mercury coolant from the TA-2 Clementine reactor was disposed at MDA C. Sludge, which was contaminated with hazardous constituents and radionuclides, from various treatment plants located at the Facility were also disposed at MDA C during its operation. (Rogers 1977; DOE 1987; LANL 1992b).

104. A variety of chemicals such as pyrophoric metals, hydrides, compressed gases, nickel carbonyl cylinders (lecture bottles about 1 pound), and carboys of di- or triethylbenzene were disposed of at Pit 6, the chemical disposal pit at MDA C. (DOE 1987).

G. Releases of Contaminants from TA-54

105. The Facility Operators have used TA-54 since the 1950's as the primary waste disposal area for the Facility. TA-54 includes a waste characterization area, container storage areas, a waste transfer facility, and numerous surface impoundments, pits, trenches, and shafts used for waste disposal. (LANL 1992d, 2000a, and 2001c).

106. More than 6500 cubic feet (approximately 48,000 gallons) of organic liquid waste, 1680 cubic feet (approximately 12,500 gallons) of inorganic liquid waste, and at least 53 cubic feet (approximately 396 gallons) of 1,1,1 trichloroethane were disposed of at MDA L in TA-54. In addition, at least another 9500 cubic feet (approximately 71,000 gallons) of unspecified waste was disposed of at MDA L, but not classifiable due to incomplete description in logbook entries. (LANL 1992d).

107. At least 114.68 cubic feet (approximately 858 gallons) of 1,1,1-trichloroethane, in addition to other wastes, was disposed of in three of the shafts at MDA L, Shafts 17, 24, and 33. (LANL 1992d).

108. A plume of organic contaminant vapor has been identified from MDA L, although not fully characterized. Monitoring of subsurface pore gas concentrations in 1999 detected trichloroethane, trichloroethylene, trichlorotrifluoroethane, methylene chloride, chloroform, toluene, 1,1-dichloroethane, and 1,1-dichloroethene, among other solvents. (LANL 2000a).

109. A plume of organic vapor and a plume of tritium vapor plume have been identified beneath MDA G at TA-54 (LANL 2000a).

H. Other Releases of Contaminants

110. Dynamic testing at firing sites in 1976 released an estimated 26 kg of beryllium, 19 kg of lead, 36 kg of mercury, and 1020 kg of depleted uranium. As reported in 1979, an estimate of the total amount of depleted and natural uranium used in dynamic testing was 100,000 kg. (DOE 1979).

111. Fractures and higher permeability units (e.g., surge beds and the "Cerro Toledo interval") facilitate contaminant migration in the subsurface at the Facility. (Rogers 1977; LANL 1991, 1998a, 1998d and 2001b).

IV. POTENTIAL FOR EXPOSURE TO CONTAMINANTS

112. Los Alamos County operates seven public water supply wells within the Facility boundary and an additional five public water supply wells within three miles to the north of the Facility. The wells draw water from the regional aquifer. Contamination has been detected in two of the

County wells north of the Facility, wells G-1 and G-1A. The contaminant detected is strontium-90. (LANL 2001c).

113. The public water supply well for the City of White Rock, PM-1, is located on the east side of the Facility in Sandia Canyon. The well draws water from the regional aquifer. (LANL 2001c)

114. Tritium, nitrate, and perchlorate have been detected in Los Alamos County water supply wells. (LANL 2001c).

115. The Pueblo of San Ildefonso operates water supply wells to the east and downgradient of the Facility. The wells draw water from the regional and alluvial aquifers. (LANL 2001c).

116. Wildlife and livestock access habitat on and downgradient from the Facility. Wildlife and livestock also make use of surface water flowing in the canyons, seeps, and springs that discharge to the surface. (LANL 1998e).

117. Concurrent with TA-21 industrial wastewater treatment plant releases, the Facility reports that in 1971, kidneys from rodents living in DP Canyon were analyzed for mercury and concentrations ranged from 0.1 to 0.7 micrograms per gram for wet tissue, compared to 0.02 to 0.1 micrograms per gram for wet tissue at a control site. Activities for plutonium and tritium in rodents were reported to have had a similar correlation. (DOE 1987).

118. Perchlorate has been detected in a municipal water supply well (Otowi-1) for Los Alamos County and located in Pueblo Canyon, approximately 5 miles downgradient of the South Fork of Acid Canyon. Detected concentrations of less than 6 µg/L are near the Environmental Protection Agency proposed drinking water equivalent of 1 µg/L. (LANL 2001c and 2002).

119. Tritium has been detected in the Otowi-1 municipal water supply well at 38 picocuries/liter. This data indicates that communication between effluent discharges and the deep regional aquifer has occurred during the last 59 years. (LANL 2001c)

V. TOXICITY OF CONTAMINANTS

120. *Barium*. Subchronic and chronic studies on rats and mice have shown kidney damage in response to oral doses of barium. Hypertension has been observed in humans who ingested high doses of barium under occupational exposure conditions. Ingestion of high levels of barium compounds over the short term has resulted in difficulties in breathing, increased blood pressure, changes in heart rhythm, stomach irritation, brain swelling, muscle weakness, damage to the liver, kidney, heart, and spleen. (EPA 2002a, ATSDR 2002).

121. *Beryllium*. Inhalation of beryllium can cause chronic beryllium disease, an inflammatory reaction to low levels of beryllium, and it may cause lung cancer. Ingestion of beryllium has not been reported to cause effects in humans because very little beryllium can move from the stomach and intestines into the bloodstream. Beryllium contact with scraped or cut skin can cause rashes or ulcers. (EPA 1998a; ATSDR 2002).

122. *Cadmium.* Cadmium can cause kidney damage through both ingestion and inhalation exposures. Cadmium has been linked with damage to the intestinal tract through ingestion and with damage to the lungs through inhalation. Cadmium is also considered to be a probable (class B) human carcinogen. Long-term exposure to lower levels of cadmium in air, food, or water leads to a buildup of cadmium in the kidneys and possible kidney disease. Other long-term effects are lung damage and fragile bones. (EPA 2002a; ATSDR 2002).

123. *Chromium (III)*. Chromium III has a much lower bioavailability than chromium (VI) and is therefore much less toxic than Chromium (VI). Chromium (III) caused reduced liver and spleen weights in animals and allergic contact dermatitis in exposed workers. (EPA 1998b).

124. *Chromium (IV)*. Inhaled chromium (VI) is a carcinogen that acts as a mutagen on DNA. Breathing high levels of chromium (VI) can cause irritation to the nose, such as nosebleeds, and ulcers and holes in the nasal septum. Ingesting large amounts of chromium (VI) can cause stomach upsets and ulcers, convulsions, kidney and liver damage, and even death. Skin contact with certain chromium (VI) compounds can cause skin ulcers. (EPA 1998c; ATSDR 2002).

125. *Cyanide*. Oral ingestion of cyanide salts (sodium cyanide and potassium cyanide) is linked in animal studies with weight loss, thyroid effects, and myelin degeneration. Exposure to lower levels of cyanide for a long time may result in breathing difficulties, heart pains, vomiting, blood changes, headaches, and enlargement of the thyroid gland. People with high blood cyanide levels have also shown harmful effects such as weakness of the fingers and toes, difficulty walking, dimness of vision, deafness, and decreased thyroid gland function. Skin contact with cyanide can produce irritation and sores. (EPA 2002a; ATSDR 2002).

126. *High Melting Explosive (HMX)*. HMX, or Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine, causes lesions in the liver, primarily in males. (EPA 2002a).

127. *Lead*. Lead has been shown to adversely affect children's neurobehavioral development by affecting the central nervous system. Lead also damages kidneys and the reproductive system. The effects are the same whether it is breathed or swallowed. At high levels, lead may decrease reaction time, cause weakness in fingers, wrists, or ankles, and possibly affect the memory. Lead may cause anemia, a disorder of the blood. It can also damage the male reproductive system. (EPA 2002a; ATSDR 2002).

128. *Mercury*. Inorganic and methylated mercury adversely affects primarily the nervous system. Methylmercury and metallic mercury vapors are more harmful than other forms, because more mercury in these forms reaches the brain. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. (EPA 2002a; ATSDR 2002).

129. *Methyl Ethyl Ketone (MEK)*. MEK, or 2-butanone, caused decreased fetal birth weight in animals through both the ingestion and inhalation pathways. Inhalation of MEK can cause irritation of the nose, throat, skin, and eyes. If MEK is inhaled along with other chemicals that damage health, it can increase the amount of damage that occurs. Exposure of animals

to high levels of MEK resulted in birth defects, loss of consciousness, and death. (EPA 2002a; ATSDR 2002).

130. *Nickel*. Exposure of animals to soluble nickel salts results in decreased body weight gain, increased heart-to-body weight ratios and decreased liver-to-body weight ratios. Once a person is sensitized to nickel, further contact with it will produce a reaction. The most common reaction is a skin rash at the site of contact. Ingestion and inhalation of nickel has been reported to cause lung disease in dogs and rats and to affect the stomach, blood, liver, kidneys, immune system, and reproduction and development in rats and mice. (EPA 2002a; ATSDR 2002).

131. *Nitrate*. Exposure to nitrate has been shown to cause methemoglobinemia resulting in cyanosis ("blue baby syndrome") in infants under 3 months of age. (EPA 2002a; ATSDR 2002).

132. *Perchlorate*. Perchlorate interferes with iodide uptake into the thyroid gland. Because iodide is an essential component of thyroid hormones, perchlorate disrupts the function of the thyroid. Changes in thyroid hormone levels may also result in thyroid gland tumors. Impairment of thyroid function in expectant mothers may impact the fetus and newborn and result in effects including changes in behavior, delayed development and decreased learning capability. (EPA 2002b).

133. *Polychlorinated Biphenyls (PCB's).* PCB mixtures consist of a number of different Aroclor compounds. These aroclors can cause liver cancer. Aroclor 154 affects eye and immune system function. Aroclor 1216 reduces birth weights and affects reproduction in primates. Animals that ingested PCB's over several weeks or months developed various kinds of health effects, including anemia; acne-like skin conditions; and liver, stomach, and thyroid gland injuries. Other effects of PCB's in animals include changes in the immune system, behavioral alterations, and impaired reproduction. (EPA 2002a; ATSDR 2002).

134. *Radionuclides*. Radionuclides are considered carcinogens based on their property of emitting ionizing radiation and on the extensive weight of evidence provided by epidemiological studies of radiogenic cancers in humans. All radionuclides are classified as known (Class A) human carcinogens by the EPA. (EPA 2001).

135. *Royal Detonating Explosive (RDX*). RDX, also known as Cyclonite or Hexahydro-1,3,5-trinitro-1,3,5-triazine, causes inflammation of the prostate. Dosing with RDX also resulted in toxicity to and increased organ weight in kidneys. Exposure to large amounts of RDX can cause seizures. (EPA 2002a; ATSDR 2002).

136. *Tetrachloroethylene (perchloroethylene or PCE)*. Tetrachloroethylene is toxic to the liver and kidney by both oral and inhalation exposure, and the central nervous system by inhalation exposure. Chronic exposure causes respiratory tract irritation, headache, nausea, sleeplessness, abdominal pains, constipation, cirrhosis of the liver, hepatitis, and nephritis in humans; and microscopic changes in renal tubular cells, squamous metaplasia of the nasal epithelium, necrosis of the liver, and congestion of the lungs in animals. The oral reference dose level set by EPA is based on toxic effects on the liver. (EPA 2002a; ATSDR 2002).

137. *Trichloroethylene (TCE)*. Human and animal data indicate that exposure to TCE can result in toxic effects on a number of organs and systems, including the liver, kidney, blood, skin, immune system, reproductive system, nervous system, and cardiovascular system. Inhalation may cause headaches, lung irritation, dizziness, poor coordination, and difficulty concentrating. Inhalation for long periods may cause nerve, kidney, and liver damage. (EPA 2002a; ATSDR 2002).

138. *2,4,6-trinitrotoluene (TNT)*. TNT has been shown to cause liver damage as a result of ingestion. TNT is a possible (class C) human carcinogen. (EPA 2002a).

139. *Toluene*. Toluene adversely affects liver and kidney function through the ingestion pathway by causing significant increases in the weights of these organs. Inhalation of toluene results in adverse neurological effects in humans. Exposure to low to moderate levels can cause tiredness, confusion, weakness, drunken-type actions, memory loss, nausea, loss of appetite, and hearing and color vision loss. Toluene has been linked to birth defects in children of exposed mothers. (EPA 2002a; ATSDR 2002).

140. *Tritium*. Tritium is considered a carcinogen based on its property of emitting ionizing radiation. Tritium is classified as a known (Class A) human carcinogen by the EPA. (EPA 2001).

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PETER MAGGIORE
Cabinet Secretary
New Mexico Environment Department

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